

Phyllomedusa spp. (Anura, Hylidae): predation by *Leptodeira annulata* (Serpentes, Dipsadidae)

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Leptodeira annulata (Linnaeus, 1758) is one of the most common snakes in the Americas and is found from southern Mexico to Argentina under various subspecies (Dunn, 1936; Duellman, 1958; Scrocchi, 1980). It measures up to 600 mm from snout to vent and is nocturnal and semi-arboreal (Vitt, 1996; Ávila and Morais, 2007). It is a generalist known to feed on lizards (Duellman, 1958; Martins and Oliveira, 1998;

Pizzatto and Singer, 2008), especially in the dry season, when the frogs are not active (Duellman, 1958), other snakes in captivity (Skehan, 1959; Petzoldh, 1969) and nature (Pizzatto and Cantor, 2008) and mainly frogs, which apparently correspond to most of the diet of this specie. *Leptodeira annulata* is known to prey on frogs at all stages of development: eggs of the subfamily Phyllomedusinae, specifically *Phyllomedusa* sp. (Duellman,

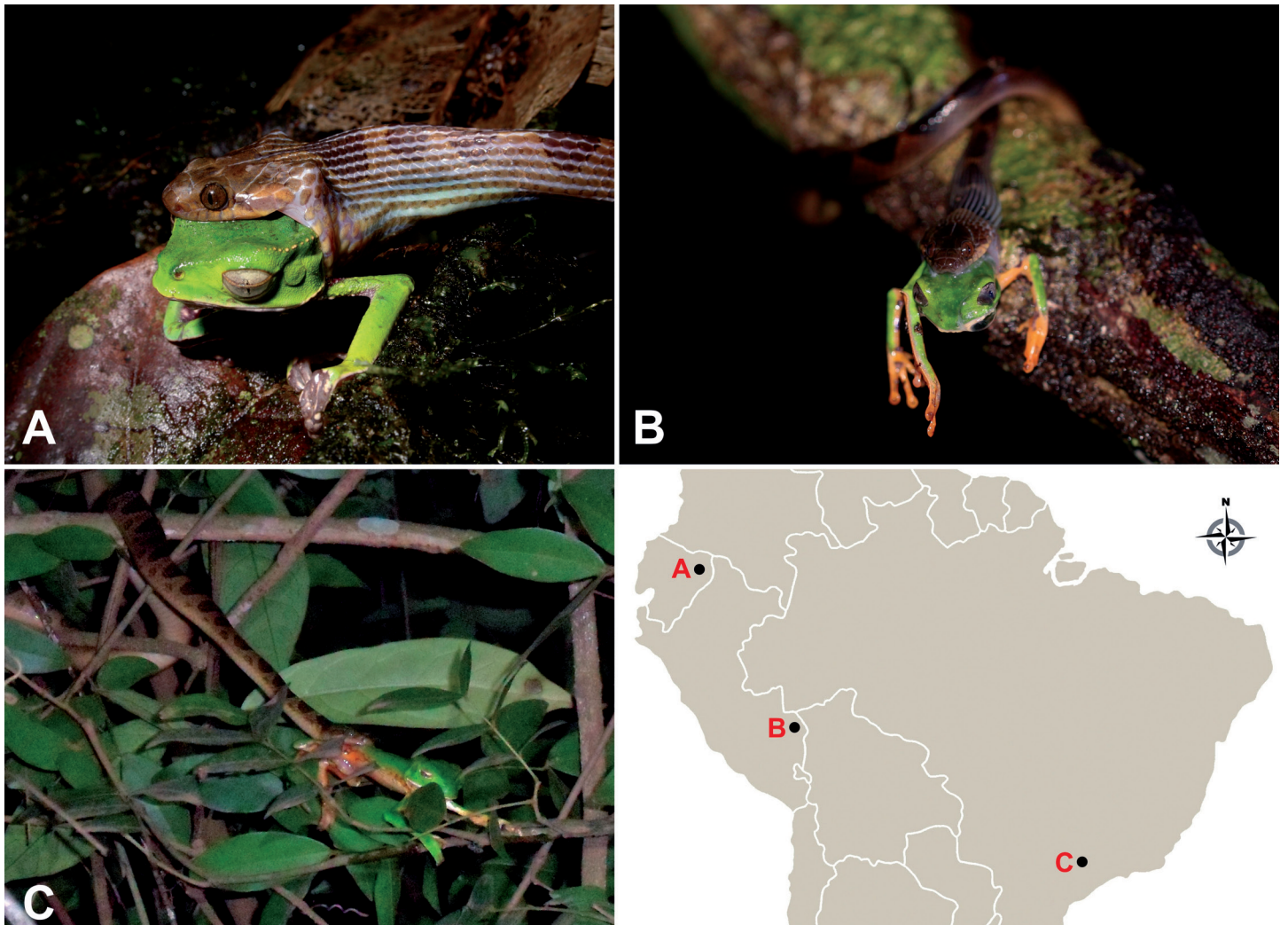


Figure 1: Preys of *Leptodeira annulata*: **(A)** *Phyllomedusa vaillanti* in Yasuni National Park, Ecuador (Photo: Manuel Mejia); **(B)** *Phyllomedusa tomopterna* in Tambopata National Reserve, Peru (Photo: Mike Ellis); **(C)** *Phyllomedusa tetraploidea* in Lençóis Paulista, Brazil (Photo: Tiago Gazoni); and map showing localities from events.

TABLE 1: Review adult frog species predated by *Leptodeira annulata*.

Prey	Locality	Reference
Bufonidae		
<i>Bufonidae</i> spp.	Southeastern and Central Brazil	Cantor and Pizzatto, 2008
<i>Incilius coccifer</i>	Guanacaste, Costa Rica	McDiarmid and Foster, 1981
<i>Incilius marmoratus</i>	Tehuantepec, Oaxaca, Mexico	Turner, 1958
<i>Incilius valliceps</i>	Santa Cecilia, Ecuador	Duellman, 1958
<i>Rhinella (Bufo) granulosa</i>	Amazon	Vitt, 1996
<i>Rhinella granulosa</i>	Corumbá, Mato Grosso do Sul State, Brazil	Ávila and Morais, 2007
<i>Rhinella margaritifera</i>	Not specified	Duellman, 1958
<i>Rhinella marina</i>	Not specified	Duellman, 1958
<i>Rhinella ornata</i>	Guapimirim, Rio de Janeiro State, Brazil	Vrcibradic <i>et al.</i> , 2007
<i>Rhinella</i> sp.	Not specified	Duellman, 1958
Hylidae		
" <i>Hyla</i> " spp.	Not specified	Duellman, 1958
<i>Cruziohyla craspedopus</i>	Amazon Peru	Lamar, 2007
<i>Dendropsophus bokermanni</i>	Santa Cecilia, Ecuador	Duellman, 1978
<i>Dendropsophus marmoratus</i>	Santa Cecilia, Ecuador	Duellman, 1978
<i>Dendropsophus parviceps</i>	Santa Cecilia, Ecuador	Duellman, 1978
<i>Dendropsophus robertmertensi</i>	Not specified	Duellman, 1958
<i>Hylidae</i> spp.	Southeastern and Central Brazil	Cantor and Pizzatto, 2008
<i>Hypsiboas boans</i>	Not specified	Duellman, 1958
<i>Hypsiboas lanciformis</i>	Santa Cecilia, Ecuador	Duellman, 1978
<i>Hypsiboas rosenbergi</i>	Costa Rica	Kluge, 1981
<i>Osteocephalus</i> sp.	Manaus, Amazonas State, Brazil	Martins and Oliveira, 1998
<i>Osteocephalus taurinus</i>	Lucas do Rio Verde, Mato Grosso State, Brazil	Campos <i>et al.</i> , 2011
<i>Osteocephalus taurinus</i>	Tarapoto, Peru	Hagman and Schulte, 2007
<i>Phyllomedusa tetraploidea</i>	Lençóis Paulista, São Paulo State, Brazil	Present study
<i>Phyllomedusa tomopterna</i>	Tambopata N. R., Puerto Maldonado, Peru	Present study
<i>Phyllomedusa vaillanti</i>	National Park Yasuni, Orellana, Ecuador	Present study
<i>Scinax boesemani</i>	Amazon	Vitt, 1996
<i>Scinax ruber</i>	Espigão do Oeste, Rondônia State, Brazil	Bernarde and Abe, 2010
<i>Scinax ruber</i>	Not specified	Duellman, 1958
<i>Scinax ruber</i>	Urupá, Rondônia State, Brazil	Silva and Silva, 2010
<i>Scinax staufferi</i>	Not specified	Duellman, 1958
<i>Smilisca baudinii</i>	Catemaco Lake, Veracruz, Mexico	Turner, 1958
<i>Trachycephalus typhonius</i>	Not specified	Duellman, 1958
Leptodactylidae		
<i>Leptodactylidae</i> spp.	Southeastern and Central Brazil	Cantor and Pizzatto, 2008
<i>Leptodactylus andreae</i>	Amazon	Vitt, 1996
<i>Leptodactylus bufonius</i>	Not specified	Duellman, 1958
<i>Leptodactylus fuscus</i>	Amazon	Vitt, 1996
<i>Leptodactylus fuscus</i>	Not specified	Duellman, 1958
<i>Leptodactylus latrans</i>	Not specified	Duellman, 1958
<i>Leptodactylus melanonotus</i>	Not specified	Duellman, 1958
<i>Leptodactylus mystaceus</i>	Amazon	Vitt, 1996
<i>Leptodactylus mystaceus</i>	São Gabriel da Cachoeira, Amazonas State, Brazil	Carvalho <i>et al.</i> , 2007
<i>Leptodactylus</i> sp.	Manaus, Amazonas State, Brazil	Martins and Oliveira, 1998
<i>Leptodactylus</i> spp.	Not specified	Duellman, 1958
Microhylidae		
<i>Chiasmocleis panamensis</i>	Gamboa, Panama	Crawford, 2007
<i>Elachistocleis magnus</i>	Espigão do Oeste, Rondônia State, Brazil	Bernarde and Abe, 2010
<i>Synapturanus rabus</i>	Amazon	Vitt, 1996
Ranidae		
<i>Lithobates palmipes</i>	Not specified	Duellman, 1958
<i>Lithobates pipiens</i>	Not specified	Duellman, 1958
<i>Lithobates vaillanti</i>	Laguna Escondida, Veracruz, Mexico	Ramirez <i>et al.</i> , 1998
<i>Lithobates vaillanti</i>	Not specified	Mora, 1999
Strabomantidae		
" <i>Eleutherodactylus</i> " sp.	Amazon	Vitt, 1996
<i>Pristimantis altamazonicus</i>	Santa Cecilia, Ecuador	Duellman, 1978

1978), *P. tarsius* (Martins and Oliveira, 1998), *P. camba* (Bernarde and Abe, 2010) and *Agalychnis spurelli* (Vargas and Bolaños, 1999); tadpoles such as *Osteocephalus oophagus* (Jungfer and Weygoldt, 1999) and adult individuals from several species. Here we report the first records of *Leptodeira annulata* preying on adult individuals of three *Phyllomedusa* species and review of adult frog species predated by this snake.

On 24 October 2009 at 21:31 h, an individual *L. annulata* was found preying an adult *Phyllomedusa vaillanti*. The record was made next to a temporary pond within Yasuní National Park (00°40'16.7"S 76°24'1.8"W, a.s.l. 238 m) in Orellana Province, Ecuador. The snake was on the ground, swallowing the treefrog from behind (Figure 1A). The frog was still alive and dragging the snake. After about 15 minutes, the frog was completely swallowed by the snake. The water body was 1 m deep in the rainy season and the marshy bank was primarily composed of grasses, shrubs and trees in primary Amazon forest. Many frogs were regularly found in this puddle, including *Engystomops petersi*, *Rhinella margaritifera*, *Hypsiboas geographicus*, *H. fasciatus*, *H. lanciformis*, *Osteocephalus* sp., *Pristimantis* spp., *Bolitoglossa* sp. and several individuals of *P. vaillanti* and frogspawn.

On 2 February 2011 at around 23:00 h, we recorded one individual *L. annulata* preying an individual *Phyllomedusa tomopterna* from behind (Figure 1B). The event occurred in Tambopata National Reserve (12°50'12.16"S 69°17'36.31"W, a.s.l. 206 m), Puerto Maldonado, Peru, in an area of primary lowland Amazon forest. The snake was on a branch 2 m above the water of a temporary rainwater pond. The water body was about 2 m wide by 13 m long and 70 cm deep.

On 29 November 2011 at 23:12 h an individual *L. annulata* was found preying an individual *Phyllomedusa tetraploidea*. The snake was on a branch 4 m over water, swallowing the frog from behind (Figure 1C). The frog resisted for several minutes, holding tightly to a small branch, but was eventually swallowed. The record was made at Rio Claro Farm in Lençóis Paulista, São Paulo State, Brazil (22°46'35.47"S 48°53'52.54"W, a.s.l. 650 m) in riparian forest at the edge of a semi-permanent water body, in a transition area between the Cerrado and Atlantic Forest. *Phyllomedusa tetraploidea* are plentiful at the site and about 20 males were vocalizing the night of this record.

On December 04, 2012, at 23:15 h, in this same location a young male *L. annulata* was found chasing a male of *P. tetraploidea*. The treefrog was at a height of 1.5 m vocalizing over a wide sheet of a typical plant of the flooded areas. The snake slowly chased behind the anuran. After about 5 min the snake struck the bite, but the frog jumped turning back hitting the ground. After about 2 min, the snake fell to the ground where it went in the opposite direction of the treefrog. Minutes later, the treefrog returned to vocalize normally.

Records in the literature describe about 40 adult frog species in the diet of *L. annulata* (Table 1). These species are distributed in six families (Bufonidae, Hylidae, Leptodactylidae, Microhylidae, Ranidae, and Strabomantidae). Apparently, *L. annulata* has no preference for animals of arboreal or terrestrial habit. When it comes to the family Hylidae, most of species predated do not have large poison glands, but *Cruziohyla craspedopus*, *Smilisca*

baudinii and *Trachycephalus typhonius*, which possess numerous well-developed venom glands (Duellman, 1956). *Leptodeira annulata* predation on adult *Phyllomedusa* spp. has not previously been reported and this may be associated with the poison found in the skin of these species. By releasing odors and fluid these frogs are considered highly unpleasant and are avoided by predators usual amphibians (Sazima, 1974). Treefrogs of Phyllomedusinae possess venom glands in the skin and secrete peptides such as bradykinin, which modifies cardiac function (Sazima, 1974; Zug et al, 1993), and dermorphin, a peptide that causes analgesia and catalepsy (Negri et al., 1992). Sazima (1974) described in detail an experiment where most individuals of *Liophis miliaris* refused to consume *P. rhodei*, since those individuals that the snake showed visible signs of discomfort, and some later regurgitated the prey.

Toxins found in the skin of the three species of *Phyllomedusa* presented in this work may not be sufficient to avoid predation by *L. annulata*. This snake is an opisthoglyphous species, with relatively simple venom composition when compared with other poisons (Mebs, 1968). Thirteen species present on the list of prey have chemical defense. This snake is probably to the frogs' secretions, allowing predation on these species of frogs. Reports in the literature show that some snakes of the genus *Chironius* apparently have adaptations that minimize or eliminate the effects of peptides secreted by *Phyllomedusa*. Bernarde and Abe (2010) reported predation by *Chironius scurrulus* on *P. camba* and Castanho (1996) recorded *Chironius exoletus* preying on *P. distincta*, being some of the few known cases where snakes prey on adult frogs of the genus *Phyllomedusa*.

Our reports support current knowledge about both groups, but further studies are necessary to determine the relative contribution of *Phyllomedusa* spp. to *L. annulata* diets in the wild, and the mechanisms used by this species to avoid the effects of the frogs' chemical defenses.

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Aparasphenodon arapapa, Acuípe, Ilhéus, BA (Foto: M. Solé)